Unit and Title of Lesson: Grade 11 Biology – Evolution: Diseases and Antibiotic Resistance

Curriculum Connections

Materials	Include in Appendix
❑ Computer ❑ Projector ❑ Internet ❑ Wireless mouse ❑ Graph paper ❑ Handouts ❑ Exit cards	❑ Appendix A: Instructions for Antibiotic Game Simulation ❑ Appendix B: Case Study – Penicillin and Antibiotic Resistance ❑ Appendix C: Exit Card

Big Ideas

- Evolution is the process of biological change over time based on the relationships between species and their environments.
- The theory of evolution is a scientific explanation based on a large accumulation of evidence.
- Technology that enables humans to manipulate the development of species has economic and environmental implications.

Ministry Expectations - Overall Expectations

C1. Analyse the economic and environmental advantages and disadvantages of an artificial selection technology, and evaluate the impact of environmental changes on natural selection and endangered species.

C2. Investigate evolutionary processes, and analyse scientific evidence that supports the theory of evolution.

C3. Demonstrate an understanding of the theory of evolution, the evidence that supports it, and some of the mechanisms by which it occurs.

Ministry Expectations - Specific Expectations

C1.2 Evaluate the possible impact of an environmental change on natural selection and on the vulnerability of species (e.g., adaptation to environmental changes can affect reproductive success of an organism) [AI, C]

C2.1 Use appropriate terminology related to evolution, including, but not limited to: *extinction, natural selection, phylogeny, speciation, niche, mutation, mimicry, adaptation,* and *survival of the fittest* [C]

C2.4 Investigate, through a case study or computer simulation, the processes of natural selection and artificial selection (e.g., selective breeding, antibiotic resistance in microorganisms), and analyse the different mechanisms by which they occur [PR, AI, C]

C3.2 Explain the process of adaptation of individual organisms to their environment (e.g., some disease-causing bacteria in a bacterial population can survive exposure to antibiotics due to slight genetic variations from the rest of the population, which allows successful surviving bacteria to pass on antibiotic resistance to the next generation)

Learning Goals

- To appreciate the discovery of antibiotics
- To understand the mechanism and significance of antibiotic resistance
- To create graphs from existing data and to interpret data tables
- To apply their knowledge regarding antibiotic resistance to real-life situations (i.e. Finish all the prescribed antibiotics, the creation of superbugs, etc.)

Prior Knowledge

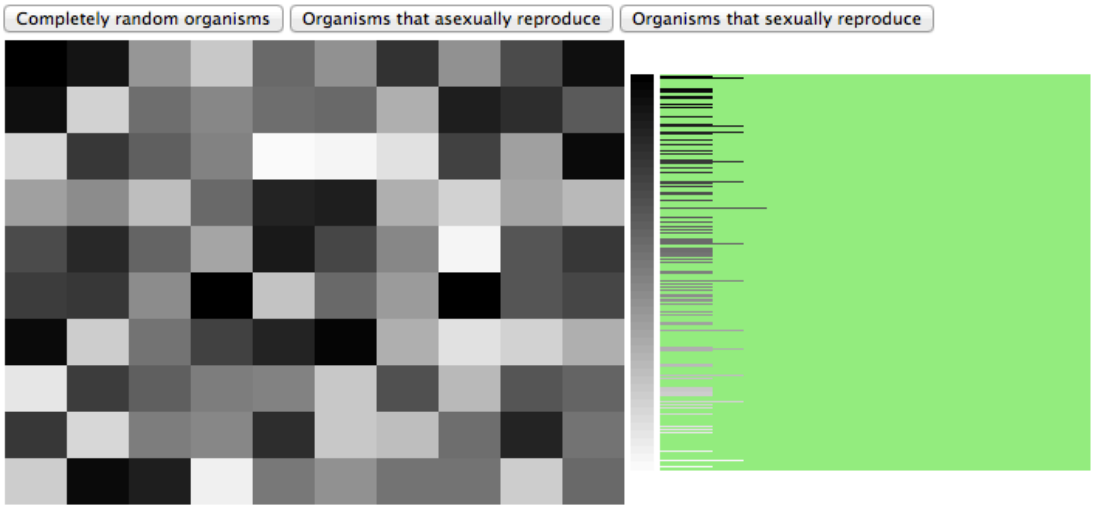
- Sustainable Ecosystems (Grade 9 Science)
- History and the theory of evolution
- Natural selection, sexual selection, artificial selection
- Genetic variation, genetic drift
- Speciation, adaptation

Time: 20 minutes	**Before: Minds On**	**Antibiotic Game Simulation** *See Appendix A* • The purpose of this game is to kill the bacteria by clicking on them. Those that survive will produce offspring with a similar colour so eventually the organisms will become harder to spot.	**Rationale for choice of T/L Strategy:** • To direct the student's attention to the lesson and to help them make connections with antibiotic resistance • To highlight the importance of killing all bacteria to ensure that the host survives • To emphasize that some bacteria are more difficult to rid than others	**Assessment Strategies:** A. Participation in the computer game
Time: 40 minutes	**During: Dry Lab**	**Case Study: Penicillin and Antibiotic Resistance** *See Appendix B* • The purpose of this dry lab is to investigate the discovery and significance of penicillin. Students will be able to see the rise of antibiotic resistance through graphs and understand the mechanism of antibiotic resistance through data tables. At the end of the lesson, students will appreciate the importance of finishing all the prescribed antibiotics. Students will also apply their knowledge to the recent superbug outbreaks. • Divide the class into small groups and allow for discussion.	**Rationale for choice of T/L Strategy:** • To study the significance of penicillin in a small group discussion. This will promote the sharing of ideas • To provide students with a chance to create graphs and interpret data. Students can work with their partners to create graphs and discuss trends • To allow students the opportunity to tie in real-life circumstances (i.e. When was the last time they had antibiotics, etc.)	**Assessment Strategies:** A. Participation in the small group discussions B. Answers from the dry lab
Time: 8 minutes	**After: Consolidation**	**Exit Cards** *See Appendix C* • Students are asked to write down three important scientific concepts that they have learned from the dry lab as an exit card	**Rationale for choice of T/L Strategy:** • To assess how much students understood antibiotic resistance • To help students reflect and summarize the lesson using their own words • To provide the teacher with feedback regarding the lesson	**Assessment Strategies:** A. Exit card responses
Time: 2 minutes	**Next Steps**	**Next Steps** • Prepare for the debate • Study for the unit test	**Rationale for choice of T/L Strategy:** • To remind students about upcoming events • To provide students with chances to see the teacher for extra help	

Appendix A: Antibiotic Game Simulation

1) Go to: http://www.kevinpluck.net/evolution-versus-intelligence/ and click "Completely random organisms"

2) Ask the students to remove the bacteria by clicking on the squares. If they miss the organism, they will be stuck for 5 seconds.



3) Allow students to attempt the game several times to come up with strategies to help their host survive. For example, killing the darker ones first, killing the lighter ones first, etc.

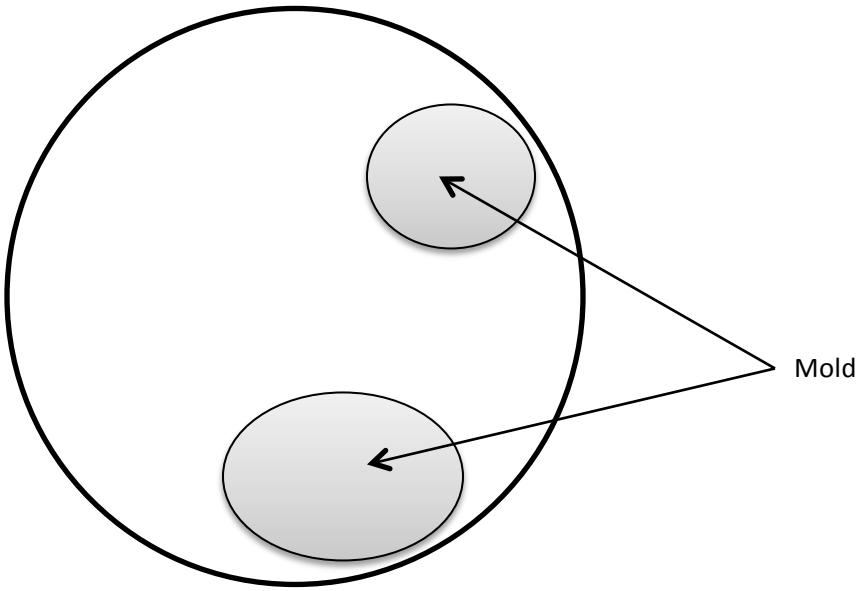
4) For a challenge, ask the students to consider the difference between asexual reproduction and sexual reproduction for the bacterial survival.

Date: _____ Name: _____

Case Study: Penicillin and Antibiotic Resistance

In 1928, Sir Alexander Fleming was doing experiments to find what destroys bacteria. He observed that on the Petri dishes where mold was growing, the *Staphylococcus aureus* bacteria adjacent to the mold were being dissolved. He then grew the mold in pure culture and found that it produced a substance that killed bacteria. This substance is what we know today as the antibiotic, **penicillin**.

Activity 1: Below is Sir Alexander Fleming's Petri dish. Shade in the bacterial distribution that he observed.



Penicillin was especially useful to treat bacterial infections during World War II. After the war, penicillin was also a common antibiotic that doctors prescribed to treat common bacterial infections. However, as early as 1942, reports began to show that patients were developing resistance to penicillin.

Activity 2: Create a graph based on the following set of values and answer the following questions.

Year	Percentage Resistant to Penicillin
1950	3
1960	6
1970	8
1980	15
1990	25
2000	37
2010	52

1) What trend is displayed from the graph?

_____

_____

2) Propose an explanation for this trend.

_____

_____

3) Observe the following table and answer the following questions.

	Number of Bacteria in Each Strain			
Days after Penicillin Use	Green	Red	Yellow	Orange
0	17	10	11	0
1	5	9	8	0
2	3	8	8	2
3	1	7	9	3
4	1	7	10	5
5	0	5	8	11
6	0	5	7	15
7	0	4	5	23

a. Based on the following table, which strain of bacteria is MOST affected by the penicillin? _____

b. Based on the following table, which strain of bacteria is LEAST affected by the penicillin? _____

c. Propose an explanation for the appearance of orange bacteria after two days of penicillin use.

_____

_____

_____

_____

d. What would happen if you stopped taking penicillin after Day 2?

_____

_____

_____

_____

e. Today, penicillin is considered one of the weaker antibiotics. Explain why scientists have developed stronger antibiotics to fight similar bacterial infections.

_____
_____
_____
_____

4) Why do you think doctors recommend that patients finish their antibiotics?

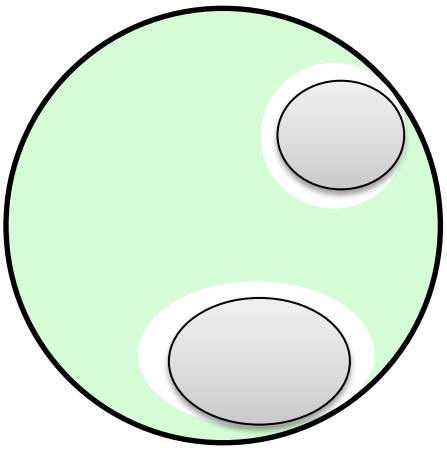
_____
_____
_____
_____

Evaluation Checklist:

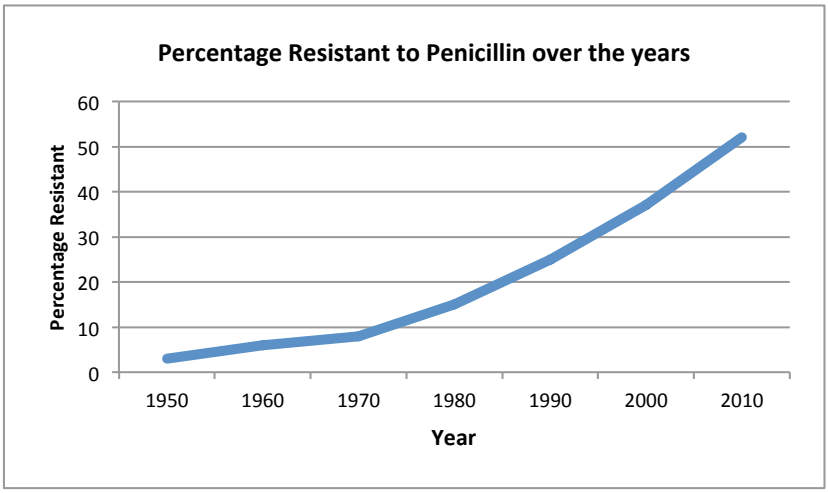
Communication	Thinking/Inquiry
Activity 1 [0 1 2] Student shade in the correct area around both molds.	
Activity 2 [0 1 2 3 4 5 6] Graph - Graph paper used - Axis labels and correct scale - Descriptive title - Correct values	
	Questions #1 **[0 1 2]** #2 **[0 1]** #3a **[0 1]** #3b **[0 1]** #3c **[0 1 2]** #3d **[0 1 2]** #3e **[0 1 2 3]** #4 **[0 1 2]**
Total /8	**Total /14**

Answer Key for Case Study – Penicillin and Antibiotic Resistance

Activity 1:



Activity 2:



1) What trend is displayed from the graph?
   The graph shows that over the years, the number of patients who are resistant to penicillin increased. This means that penicillin is no longer effective to treat bacterial infections.

2) Propose an explanation for this trend.
   The bacteria gained resistance to the penicillin so it is no longer effective.

3) Observe the following table and answer the following questions.
   a. Based on the following table, which strain of bacteria is MOST affected by the penicillin? Green
   b. Based on the following table, which strain of bacteria is LEAST affected by the penicillin? Orange
   c. Propose an explanation for the appearance of orange bacteria after two days of penicillin use.
      The Red and Yellow bacteria underwent sexual reproduction to create a new strain of Orange bacteria. This bacteria carry resistance to the antibiotic.
   d. What would happen if you stopped taking penicillin after Day 2?
      The Green bacteria would continue to thrive and the Orange bacteria would reproduce as well.
   e. Today, penicillin is considered one of the weaker antibiotics. Explain why scientists have developed stronger antibiotics to fight similar bacterial infections.
      Patients have developed resistance to penicillin. Meanwhile, the bacteria have mutated or have sexually selected into becoming superbugs. These bacteria are immune to weak doses of penicillin and need stronger doses or different antibiotics altogether to kill the infection.

4) Why do you think doctors recommend that patients finish their antibiotics?
   Patients need to finish their antibiotics so that bacteria are completely killed, otherwise, it could mutate or reproduce and become immune to the drugs.

Appendix C: Exit Card

EXIT Card

List three scientific concepts that you have learned today:

1.

2.

3.